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High precision laser spectroscopy of Nickel isotopes

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Nickel isotopes $^{58-68,70}$Ni were measured using collinear laser spectroscopy at the COLLAPS setup at CERN-ISOLDE. Nickel has magic proton number 28, the first magic number that is caused by the spin-orbit interaction and the isotope chain is state-of-the-art in nuclear structure research. One of these is the sub-shell closure at N=40, which has been intensively studied by various experimental methods [1-5]. In the whole region, ^{68}Ni is expected to exhibit the strongest sub-shell closures and this is visible in the behavior of the now measured mean-square charge radii crossing N=40.
Furthermore, a tight correlation between neutron-radii, the electric dipole polarizability α_D and the neutron equation of state (EOS) has been intensively discussed first based on Skyrme Hartree-Fock models, linking nuclear properties with the structure of neutron stars. Of particular interest in this respect are also recent ab initio calculations entering into the medium mass region and demonstrating a clear correlation between the charge radius, the neutron radius and α_D in the case of ^{48}Ca [6].
Indeed, this correlation was exploited to predict α_D based on ^{48}Ca's experimental charge radius in reasonable agreement with a recent measurement [7]. Ab initio calculations now become feasible in the Nickel mass region as well. Recent α_D measurements in ^{68}Ni [8] are now backed up by our experimental value for the mean-square charge radius making this a rare case where both observables are experimentally known and will therefore provide an important new benchmark for ab initio as well as density functional theory.

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